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# Ocean Data Inventory (ODI): A Database of Ocean Current, Temperature and Salinity Time Series for the Northwest Atlantic

# Inventaire des données océaniques (ODI) : une base de données sur les séries chronologiques de données sur les courants océaniques, la température et la salinité pour l'Atlantique Nord-Ouest

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## ABSTRACT

The Ocean Data Inventory (ODI) database is a web accessible inventory of ocean current, temperature and salinity time series data held by the Ocean Sciences Division at the Bedford Institute of Oceanography. The data archive includes data from about 5700 current meters, 4500 thermographs, temperature chains and thermosalinographs and 200 tide gauges. The coverage area is roughly defined as the North Atlantic and Arctic from 35°N - 82°N.

In addition to research programs at the Bedford Institute, data have been obtained from the Northwest Atlantic Fisheries Center (St. John's, Nfld), Institut Maurice Lamontagne (Mont Joli, P.Q.), the former Bayfield Laboratory (Burlington, Ont.) as well as Canadian universities (e.g. Dalhousie, McGill) and US research institutes and agencies such as WHOI and USGS. A significant number of current series have been obtained from the oil and gas industry as part of the offshore drilling on the Scotian Shelf, Grand Banks and Labrador Shelf.

The database can be accessed at web address
http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.



## RÉSUMÉ

La base de données ODI (Ocean Data Inventory) est un inventaire en ligne de toutes les séries chronologiques de données sur les courants océaniques, la température et la salinité conservées par la Division des sciences océanologiques de l'Institut océanographique de Bedford. Les données archivées ont été recueillies au moyen de quelque 5 700 courantomètres, 4 500 thermographes, réseaux de sondes de température et thermosalinographes et 200 marégraphes. La zone de couverture est grossièrement définie comme l'Atlantique Nord et l'Arctique, de 35° à 82° de latitude nord.

En plus de celles provenant des programmes de recherche de l'Institut Bedford, les données sont obtenues du Centre des pêches de l'Atlantique Nord-Ouest (St. John's, Terre-Neuve), de l'Institut Maurice-Lamontagne (Mont Joli, Québec), de l'ancien Laboratoire Bayfield (Burlington, Ontario), d'universités canadiennes (p. ex. Dalhousie, McGill) et d'instituts et organismes de recherche américains (WHOI, USGS). Le secteur des hydrocarbures fournit aussi un grand nombre de séries de données sur les courants, recueillies dans le cadre des activités de forage en mer sur le plateau néo-écossais, les Grands bancs et le plateau continental du Labrador.

La base de données est disponible en ligne à l'adresse suivante :
http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query_f.html.

## INTRODUCTION

The Ocean Data Inventory (ODI) database is a web-accessible inventory[1] of ocean current, temperature and salinity time series data held by the Ocean Sciences Division at the Bedford Institute of Oceanography. All of the data reported in the inventory are held at the Bedford Institute, although a substantial amount of the data originate with (and are archived by) other sources. In addition to research programs at the Bedford Institute, data have been obtained from the Northwest Atlantic Fisheries Center (St. John's, Nfld), Institut Maurice Lamontagne (Mont Joli, P.Q.), the former Bayfield Laboratory (Burlington, Ont.) as well as Canadian universities (e.g. Dalhousie, McGill) and US research institutes and agencies such as WHOI and USGS. A significant number of current series have been obtained from the oil and gas industry as part of the offshore drilling on the Scotian Shelf, Grand Banks and Labrador Shelf. Previous technical reports[4,5,6] have summarized the data holdings available at the time. With the introduction of the present version of ODI, the information is provided on-line at http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.

## DISTRIBUTION

As of November 2004, the data archive includes statistics from about 5700 current meters, 4500 thermographs, temperature chains and thermosalinographs and 200 tide gauges. Since many of current meters include temperature and conductivity sensors, statistics from a total of 3200 salinity series and 8000 temperature series are available in the database. The coverage area is roughly defined as the North Atlantic and Arctic from 35° - 82° N, although there are some minor amounts of data from other parts of the world. The earliest current meter deployments are from 1960.

Figures 1, 2 and 3 show the spatial distribution of current and temperature measurements contained in the database as of November 2004. Almost half of the deployments are from the Scotian Shelf, Gulf of Maine and Bay of Fundy area.

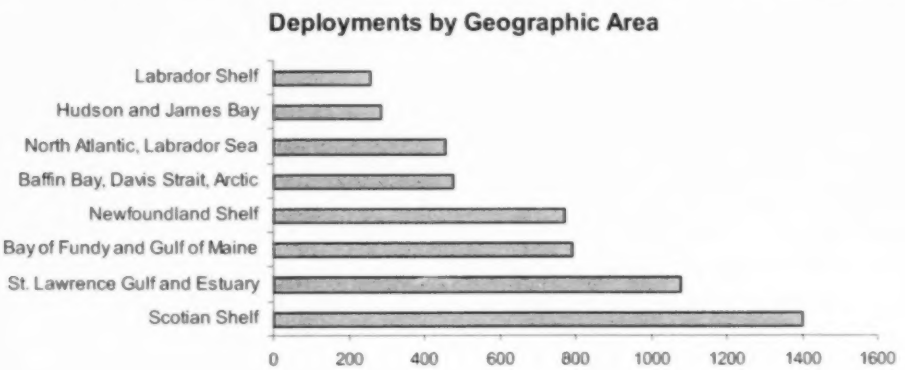


**Figure 1.** Number of current meter deployments by geographic Area

**Figure 2.** Current measurements reported in ODI as of November 2004

**Figure 3.** Temperature measurements reported in ODI as of November 2004

The deployment of current meter moorings peaked during the late 1970s and early 1980s. (Figure 4). Fewer moorings have been partially compensated by a continuing trend to longer deployments permitted by improved mooring techniques and instrumentation. During the 1970s, series length averaged 60 days. Deployments from the last four years now average almost 200 days.

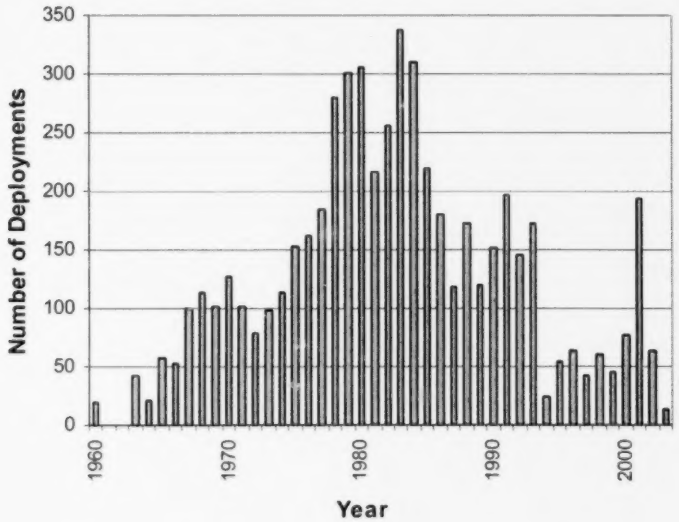


**Figure 4.** Current meter deployments in ODI by year

All of the tide gauge measurements reported in ODI are from Aanderaa pressure gauges. Almost all of the gauges have been deployed on the continental shelf or shelf break in 1200m of water or less. A small number of deep water measurements have been made in the Labrador Sea and Baffin Bay.

## INSTRUMENTATION

Many types of current meters and thermographs have been used over the four decades of measurements represented in the inventory. The early current measurements were made with a film recording instrument called the Hydrowerkstatten in use at BIO primarily for inshore tidal surveys from the early 1960's until 1976. Braincon, another film recording instrument, was used extensively from 1965 until it was retired in 1977. Aanderaa current meters were first introduced in 1971 and represent the majority (over 60%) of all the current measurements made at BIO. Most of the Aanderaa instruments also contain pressure, temperature and conductivity sensors. The most recent model (RCM-11) is an acoustic Doppler instrument. Acoustic Doppler profiling instruments (ADCP) are also being introduced in increasing numbers. ADCP instruments provide a much superior vertical resolution of current, but do not provide temperature or

salinity measurements. At least 15 types of instruments from other manufacturers are also represented, but collectively represent less than 8% of all deployments.

The thermographs reported in the inventory also represent a variety of technologies. From 1967 until 1990 the primary instrument was an analogue recording thermograph that was manually digitized at a four-hour interval. Starting in 1989, the measurements were made with digital instruments from a variety of manufacturers that recorded at hourly or half hourly intervals. The last mechanical instrument was used in 1992. For enhanced access to nearshore thermograph data, the user is referred to the Coastal Time Series database[2].

## DATABASE CONTENTS

In addition to reporting the data record, the inventory includes monthly statistics for ocean currents, temperature and salinity. For temperature and salinity, the statistics include the mean, maximum, minimum, and standard deviation for each month during deployment. Partial months are included. For vector (current) data, the statistics include maximum speed (without regard to direction), magnitude and direction of the mean current, and the principal axis components for the data as observed (referred to as high frequency), and with the tide removed (low frequency). Tide removal is accomplished by applying a simple boxcar filter if necessary to sub sample at hourly intervals, and then applying a Cartwright filter of 129 weights with a high-frequency cutoff of 0.864 cycles/day (corresponding to a period of 27.7 hours). This effectively removes the semi-diurnal and diurnal tidal frequencies.

The principal axes analysis determines the orientation of the maximum and minimum variance and is a measure of the variability of the current. The direction corresponds to that of the major axis in degrees true. When used with the vector mean and making some assumptions about the distribution, (i.e. mean +/- N standard deviations), the current extremes in both the sub-tidal and tidal bands can be estimated.

Metadata associated with the statistics include geographic position, start and end date/time, sampling depth, original sampling interval, instrument manufacturer and instrument serial number.

Moored Acoustic Doppler Current Profiler instruments (ADCP) are increasingly being used, and the data are reported differently in ODI. A single ADCP instrument can result in up to 64 individual series, one for each vertical bin. For reporting purposes, ODI contains three series that are intended to be representative of the measured water column. These series are comprised of an average of the 2 bins nearest the surface, the 2 deepest bins, and 2 bins from the middle of the profile. Moored ADCP instruments can be recognized as having a MADCPS prefix to the event identifier.

## DATA VALIDATION

All of the data are initially quality controlled by the originating source. The quality flags in the database are determined solely by the monthly statistics. The statistics are subjected to a series of tests and assigned quality flags as described below.

| Quality | Description | |
|---|---|---|
| 1 | Did not fail any of the tests | |
| 2 | Extremes greater than 4 standard deviations from the monthly mean (spiking) | |
| 3 | Constant value | |
| | Current | mean speed = maximum speed |
| | Temperature | minimum = maximum |
| | Salinity | minimum = maximum |
| 4 | Extremes out of range | |
| | Current | maximum speed ≥ 2.5 m/s or mean speed ≥ 1.0 m/s |
| | Temperature | minimum ≤ -2.5°C. or maximum ≥ 30°C. |
| | Salinity | minimum ≤ 1 psu or maximum ≥ 37 psu |
| 5 | Mean out of range | |
| | Current | mean speed < threshold velocity or ≥ 2.5 m/s. |
| | Temperature | mean ≤ -2.5°C or ≥ 30°C. |
| | Salinity | mean ≤ 1 psu or ≥ 37 psu |

Time series that have any test failure are re-examined and edited if possible (usually involving de-spiking of the data by a median filter or by linear interpolation). Any statistics that have a quality of 3 or greater are retained but not reported in a query. Statistics that have a quality of 2, but no obvious spiking outside of the background variability, are reported in a query.

## DATA ACCESS

Data in the Ocean Data Inventory are freely available to anyone. Up-to-date details and access to the database can be found at the Ocean Science web site[1] http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.

Because the query application is constantly undergoing enhancements in response to user requests, a detailed description of the application is not provided. Some of the features include the following:

The use of ODI requires a one-time registration. Registration permits access to ODI and other Ocean Science databases. Additional databases consist of:

- Climate[3] - a collection of temperature and salinity profile data for the Northwest Atlantic and Eastern Arctic
- Coastal Time Series[2] (CTS) - daily temperature observations for moored thermographs archived at BIO.
- Sea Surface Temperature (SST) – weekly composite sea-surface temperature observations from NOAA satellite.

A description of all the databases available is also described at the Ocean Science web site[1] http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.

Users can specify spatial and temporal criteria with latitude/longitude ranges, user or system defined polygons, multiple depth ranges, and time windowing options. Queries are saved and can be edited and re-run at any time.

ODI only contains monthly statistics. Complete time series data can be made available on request. Each time series is associated with an event specification (event_spec) that uniquely identifies the series. Original data series can be obtained by emailing the author and including a list of the required event_specs. Requested data files will be placed on our anonymous ftp server.

## ACKNOWLEDGMENTS

A northwest Atlantic data compilation such as ODI requires the cooperation and coordination of a number of organizations. DFO regional labs in St. John's Nfld., Mont-Joli P.Q. and St. Andrews N.B. have all contributed data. The Marine Environmental Data Service co-ordinates the very significant data contributions from the oil and gas industry. Universities and other government organizations in Canada and the United States have also contributed to the archive. Karen Atkinson maintains and updates the database. The database application was developed and continues to be improved by Science Informatics at BIO.

The (Canadian) Program of Energy Research and Development (PERD) has supported currents data processing and archival. The GeoConnections program has supported development of the web access to the database.

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